

# Agentcities: A Worldwide Open Agent Network

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## 1 Introduction

Over the past decade, agent research has reached a significant level of maturity with well-established theories, languages and methodologies. Despite these successes, the vision of agents as intelligent, autonomous entities seamlessly interacting with one another in open heterogeneous environments [Hewitt90] has yet to be realised. As Nwana and Ndumu [Nwana98] point out "the devil in realising the promises of agent technology is in the details." These details include the challenging coordination, communication, discovery, trust, security and ontology issues that are found in truly open environments where agents that are owned by many different individuals and organisations can interact and interoperate.

In this paper, we introduce *Agentcities*, an initiative to create a global, open, heterogeneous network of agent platforms and services to which any agent researcher can connect their agents. We believe that *Agentcities* will become instrumental in the take-up of agents on a global scale and help realise some of the great potential of agent technology. *Agentcities* is based on the principles of:

- **Consensual standards.** Communication and interaction in the network will be based on publicly available standards, such as those developed by the Foundation for Intelligent Physical Agents [FIPA00] and the W3C.
- **Open source.** Although commercial technologies are not discouraged, *Agentcities* will promote freely accessible open source implementations to ensure free and open access to the network.
- **Open access.** Any organisation or individual can set up their own *Agentcity* in the network to host their own agent services, provide access to them and access those deployed by others.
- **Shared resources.** As researchers access agent-based services in the network, such as directory, naming, ontology and application services, they are encouraged to add their own services to extend the utility and diversity of the services available to the community.

The following sections detail the *Agentcities* project, its concept, objectives, development timeline and the activities underpinning the effort.

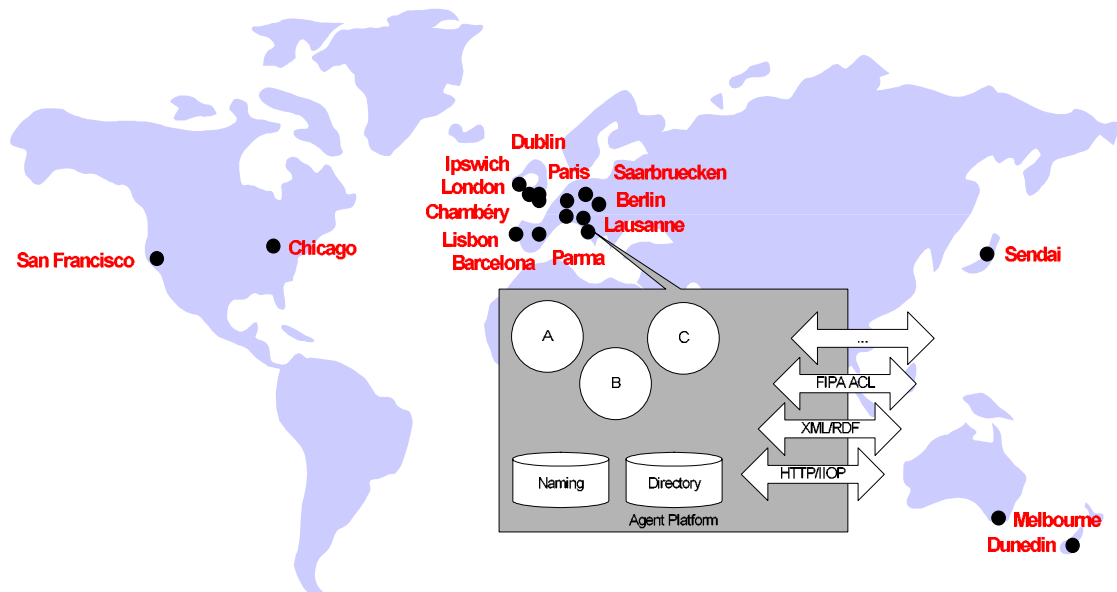
## 2 The Agentcities Project

Most agents are by their very nature sociable and as such need to interact with other agents to accomplish their tasks. In general this requires them to:

- Discover other agents and establish the capabilities of these agents in terms of the services that they provide.
- Communicate with one another to exchange information, form commitments, negotiate, and so forth.
- Provide services to one another in a coordinated manner, enabling groups of agents to dynamically compose their services and perform complex tasks.

The Agentcities project aims to create a network where agents that are running on different platforms, owned by different organisations, implemented in different ways and providing diverse services can interact. Although standards such as DAML+OIL, ebXML, XML, RDF and others are relevant, the basis for this interoperability will be the FIPA standard for software agents [FIPA00].

The nodes in the Agentcities network (see *Figure 1*) are agent platforms that are running on one or more machines and are hosted by an organisation or individual<sup>1</sup>. Agents running on a particular platform are able to connect to other publicly available platforms and communicate directly with their agents. Application services which combine component agent services from different Agentcities can be created through the flexible use of this inter-agent communication model and the semantic frameworks, shared ontologies, content languages and interaction protocols that support it.



**Figure 1:** The Agentcities Network

Some nodes in the network will further provide useful services such as directory services (white and yellow pages), ontology services (simple repositories or more complex services for sharing ontology definitions), gateways (to perform translations between, for example, different transport protocols, languages, security domains and the like), testing and bootstrapping (automated systems to test the interoperability of platforms and to enable simple debugging and monitoring).

<sup>1</sup> The list of announced Agentcity nodes is growing as new projects are announced and funded. See <http://www.agentcities.org> for an up to date list.

Deploying agents consists of installing an agent platform on a machine connected to the Internet and announcing the address of the new platform. Agents on the platform can then interact with other agents already in the network to register their services in public directories and to search for and take advantage of new services in the distributed environment.

### 3 Agentcities Applications

Whilst infrastructure (messaging, directories, etc) is necessary to create the network, the objective of the Agentcities project is not simply to deploy infrastructure. Nwana, in [Nwana98], comments that many of the real challenges of deploying and using such a network lie in how diverse services can discover each other, the development and usage of ontologies, the application of a semantic framework, and how coordination can be achieved between heterogeneous systems. The primary objective of Agentcities is, therefore, to create a rich, open environment to explore these questions.

Although a number of the projects underpinning Agentcities take the area of travel, tourism and entertainment as their application domain, there is no restriction on the applications that could be deployed in the Agentcities network. The main example of developing a platform in the network to model the services available in a town or city (hence the name *Agentcities*) simply provides a convenient domain focus to begin tackling the problems of semantics, ontology and dynamic service composition in manageable proportions. Other groups are already considering very different application domains and how to exploit Agentcities in their own way. Interest groups that are already forming include:

- **Travel, tourism and entertainment services:** Focal application area of the EU Agentcities research project (see *Section 4.1*).
- **Business services:** Market places, payment systems, transactions and catalogue services.
- **Coordination technologies:** Coordination media and shared coordination methods.
- **Medical and healthcare services:** Distributed services for organ transplantation, access to patient medical records and local emergency services linked with existing projects and new activities.
- **Manufacturing and supply chain integration:** Using the Agentcities infrastructure as a substrate for coordinating distributed manufacturing processes and supply chain integration.
- **Security services:** Using the Agentcities infrastructure as a testbed for analysing and beginning to address the security needs of such open, heterogeneous environments.
- **eLearning:** Distributed agent based tutoring systems.
- **Wireless applications:** Seamless interaction between wireless and wire line agents to dynamically composed service based on user location.
- **Personalisation:** Dynamic composition of user services to suit individual tastes.

### 4 Projects, Activities and Relationships

At the time of writing there are the following Agentcities activities are planned or in existence:

- Two projects (Agentcities.RTD and Agentcities.NET) funded by the European Commission's 5th Framework IST program (14 and over 50 partners respectively).
- Related project funding proposals submitted in Canada (19 partners), France (7 partners), Finland (2 partners) and Hungary (4 partners).
- Projects planned in Japan (8 partners), the United States (12 partners), Australia, New Zealand and Switzerland.
- An active mailing list with over 150 members from over 80 organisations.

Although projects each have their own aims, they are unified in the objective of creating a global interoperability infrastructure based on common standards.

## 4.1 Agentcities.RTD

The Agentcities.RTD project [ACRTD00] is a *research project* funding the deployment of 14 Agentcities platforms, each of which is hosted by a different project partner in a world city (see *Table 1*). This project will lay the foundations for the Agentcities network, develop services, deploy platforms, network infrastructure, example applications and perform key research in the areas of communication frameworks, network architecture and dynamic service composition. It is expected that this infrastructure will outlive the project and serve as a core for future agent applications.

<b>Start Date</b>	July, 2001	
<b>Duration</b>	2 years	
<b>Partners</b>	<b>Organisation</b>	<b>City and Country</b>
	ADETTI	Lisbon, Portugal
	Aegis	Chambery, France
	Broadcom Eireann	Dublin, Ireland
	BTexact Technologies	Ipswich, UK
	Communication Technologies	Sendai, Japan
	DFKI	Saabruecken, Germany
	Ecole Polytechnique Federale de Lausanne	Lausanne, Switzerland
	Fujitsu Laboratories of America	San Francisco, USA
	Imperial College London	London, UK
	Motorola	Paris, France
	PopNet Agentscape	Berlin, Germany
	Queen Mary University of London	London, UK
	University of Parma	Parma, Italy
Universitat Polytechnica de Catalunya	Barcelona, Spain	

**Table 1:** Details of the Agentcities.RTD Project

## 4.2 Agentcities.NET

The AgentCities.NET project [ACNET00] is a *take-up measure* project engaging in a series of concerted actions to make the Agentcities network accessible to the research and business community in Europe. Membership is open to all interested parties<sup>2</sup> and planned actions include:

- **Information days:** providing easy access to information on how to exploit and get involved in the network.
- **Deployment support grants:** to provide small starter grants to organizations wishing to connect their own systems to the network.
- **Student exchange program:** supporting student projects in areas related to the Agentcities network by funding short exchanges between Agentcities.NET participants.
- **Application competitions:** encouraging development by recognising the most innovative new applications created in the network
- **Working groups:** structures to help cluster interest around certain topics and domain areas.

Although actions involving financial contributions are targeted at EU organizations, events and participation will also be open to organisations from non-EU countries. To date 50 organisations

<sup>2</sup> For more details, see <http://www.agentcities.org/EUNET/>

(in addition to the 14 involved in the Agentcities.RTD project) have submitted statements expressing an interest in participating in the project.

<b>Start Date</b>	November, 2001
<b>Duration</b>	18 months
<b>Information Day</b>	February, 2002
<b>Statements of Interest</b>	50 Organisations

**Table 2:** Details of the Agentcities.NET Project

### 4.3 Agentcities Task Force

With so many activities underway the formation of an “Agentcities Task Force” (ACTF) to act as an open forum for the global coordination of various Agentcities related efforts is currently under discussion. The ACTF will support:

- **Coordination:** Facilitate coordination between different projects and activities contributing to and using the Agentcities network.
- **Network support:** Encourage and support joint resources such as directories, ontology repositories and the like.
- **Promotion, dissemination and liaison:** Raise awareness of work being carried out in the network to effectively contribute to existing standards bodies and to encourage increased interest, participation and development.

The ACTF will act as a body to support the coordination of different Agentcities projects, and liaise with relevant standard bodies where the Agentcities community might bring valuable experimental feedback on agent platforms, content representation, ontologies, content manipulation, agent communication and interaction protocols. At the time of writing, the ACTF is still being formed and a consultation process is underway. Comments on its structure, objectives, creation and participation (see [ACTF01]) are very welcome and can be made either publicly to the [discussion@agentcities.org](mailto:discussion@agentcities.org) mailing list or privately to one of the authors.

An open ACTF meeting will be held on 5th October, 2001 in Palo Alto California, please contact [bernard\\_burg@hpl.hp.com](mailto:bernard_burg@hpl.hp.com) for more information.

### 4.4 How to Participate

For more information and contact details for the Agentcities project, visit the Agentcities web site at <http://www.agentcities.org/>

### 4.5 Important Dates

Experimentation in constructing the network has been ongoing since the end of 2000 and there are currently four platforms deployed; a significant increase in activity will occur in July 2001 with the start of the Agentcities.RTD project (see *Table 3*).

<b>Date</b>	<b>Event</b>
July, 2001	Start of Agentcities.RTD project
September, 2001	Public availability of the initial network of 14 platforms
October, 2001	ACTF meeting
November, 2001	Start of Agentcities.NET project

January, 2002	First public Agentcities.NET information day
February, 2002	Other projects beginning to start worldwide

**Table 3:** Important Dates and Events for the Agentcities Project

## 5 Related Efforts

Amongst the most important related initiatives are:

- **DARPA COABS GRID** [GRID00]: This provides software plug-ins to allow heterogeneous agent and AI systems to connect to each other using JINI™ technology. There are efforts planned to build gateways between the GRID and Agentcities deployed networks.
- **FIPA:** The Foundation for Intelligent Physical Agents (FIPA) is an independent standards body supported by 65 organizations worldwide and has defined a series of comprehensive agent standards. To date, sixteen different FIPA-compliant agent platforms have been implemented and five of them are freely accessible under open source license
- **Semantic Web:** Efforts within W3C and in European Union/DARPA funded research projects OntoKnowledge, OntoWeb, DAML and others are developing web-friendly ontology frameworks that may dramatically alter the way agents experience the environment.

There are also a large number of other projects, technologies and standards which are relevant to Agentcities and will become more so as the network develops. These include infrastructure services such as UDDI and SOAP, electronic business frameworks such as ebXML and RosettaNet, as well as the work of current and new European Union research projects such as: ALFEBIITE (see [ALFEBITTE00]), LEAP (see [LEAP00]), and, CRUMPET (see [CRUMPET99]).

## 6 Conclusion

We believe that the Agentcities project will have a significant impact on the global deployment of agents and will provide a useful resource for the development of the next generation of networked systems. However, Agentcities is not attempting to be the panacea of agent or network programming since much hard work is involved in developing ontologies, using semantic frameworks and content languages before agents can communicate. Therefore, the role of the Agentcities project is to stimulate this process and encourage researchers to think in an open context and to envisage their systems in the context of a worldwide environment. The process of connecting an increasing number of diverse agent systems will teach us much about which details matter when it comes to creating true interoperability, not just at the syntactic layer, but also at the semantic layer.

## 7 Acknowledgements

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